NASA/DoD Aerospace Knowledge Diffusion Research Project

NASA Technical Memorandum 109169

Report Number 31

The Technical Communications Practices of U.S. Aerospace Engineers and Scientists: Results of the Phase 1 SME Mail Survey

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December 1994

KNOWLEDGE DIFFUSION INNOVATION
NASA DoD AEROSPACE

National Aeronautics and Space Administration

Department of Defense

INDIANA UNIVERSITY

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ABSTRACT

The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. Little is also known about the intermediary-based system that is used to transfer the results of federally funded R&D to the U.S. aerospace industry. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* In this report, we summarize the literature on technical reports, present a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-à-vis the technical communication practices of U.S. aerospace engineers and scientists affiliated with, not necessarily members of, the Society of Manufacturing Engineers (SME).

INTRODUCTION

NASA and the DoD maintain scientific and technical information (STI) systems for acquiring, processing, announcing, publishing, and transferring the results of government-performed and government-sponsored research. Within both the NASA and DoD STI systems, the U.S. government technical report is considered a primary mechanism for transferring the results of this research to the U.S. aerospace community. However, McClure (1988) concludes that we actually know little about the role, importance, and impact of the technical report in the transfer of federally funded R&D because little empirical information about this product is available.

We are examining the system(s) used to diffuse the results of federally funded aerospace R&D as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* This project investigates, among other things, the information-seeking behavior of U.S. aerospace engineers and scientists, the factors that influence the use of STI, and the role played by U.S. government technical reports in the diffusion of federally funded aerospace STI (Pinelli, Kennedy, and Barclay, 1991; Pinelli, Kennedy, Barclay, and White, 1991). The results of this investigation could (1) advance the development of practical theory, (2) contribute to the design and development of aerospace information systems, and (3) have practical implications for transferring the results of federally funded aerospace R&D to the U.S. aerospace community. The project fact sheet is Appendix A.

In this report, we summarize the literature on technical reports, provide a model that depicts the transfer of federally funded aerospace R&D through the U.S. government technical report, and present the results of the Phase 1 SME mail survey. We summarize the findings of the Phase 1 mail survey in terms of the technical communication practices of U.S. aerospace engineers and scientists affiliated with, not necessarily members of, the Society of Manufacturing Engineers (SME).

THE U.S. GOVERNMENT TECHNICAL REPORT

Although they have the potential for increasing technological innovation, productivity, and economic competitiveness, U.S. government technical reports may not be utilized because of limitations in the existing transfer mechanism. According to Ballard, et al., (1986), the current system "virtually guarantees that much of the Federal investment in creating STI will not be paid back in terms of tangible products and innovations." They further state that "a more active and coordinated role in STI transfer is needed at the Federal level if technical reports are to be better utilized."

Characteristics of Technical Reports

The definition of the technical report varies because the report serves different roles in communication within and between organizations. The technical report has been defined etymologically, according to report content and method (U.S. Department of Defense, 1964); behaviorally, according to the influence on the reader (Ronco, et al., 1964); and rhetorically, according to the function of the report within a system for communicating STI (Mathes and Stevenson, 1976). The boundaries of technical report literature are difficult to establish because of wide variations in the content, purpose, and audience being addressed. The nature of the report -- whether it is informative, analytical, or assertive -- contributes to the difficulty.

Fry (1953) points out that technical reports are heterogenous, appearing in many shapes, sizes, layouts, and bindings. According to Smith (1981), "Their formats vary; they might be brief (two pages) or lengthy (500 pages). They appear as microfiche, computer printouts or vugraphs, and often they are loose leaf (with periodic changes that need to be inserted) or have a paper cover, and often contain foldouts. They slump on the shelf, their staples or prong fasteners snag other documents on the shelf, and they are not neat."

Technical reports may exhibit some or all of the following characteristics (Gibb and Phillips, 1979; Subramanyam, 1981):

- Publication is not through the publishing trade.
- Readership/audience is usually limited.
- Distribution may be limited or restricted.

- Content may include statistical data, catalogs, directions, design criteria, conference papers and proceedings, literature reviews, or bibliographies.

- Publication may involve a variety of printing and binding methods.

The SATCOM report (National Academy of Sciences - National Academy of Engineering, 1969) lists the following characteristics of the technical report:

- It is written for an individual or organization that has the right to require such reports.

- It is basically a stewardship report to some agency that has funded the research being reported.

- It permits prompt dissemination of data results on a typically flexible distribution basis.

- It can convey the total research story, including exhaustive exposition, detailed tables, ample illustrations, and full discussion of unsuccessful approaches.

History and Growth of the U.S. Government Technical Report

The development of the [U.S. government] technical report as a major means of communicating the results of R&D, according to Godfrey and Redman (1973), dates back to 1941 and the establishment of the U.S. Office of Scientific Research and Development (OSRD). Further, the growth of the U.S. government technical report coincides with the expanding role of the Federal government in science and technology during the post World War II era. However, U.S. government technical reports have existed for several decades. The Bureau of Mines *Reports of Investigation* (Redman, 1965/66), the *Professional Papers of the United States Geological Survey*, and the *Technological Papers of the National Bureau of Standards* (Auger, 1975) are early examples of U.S. government technical reports. Perhaps the first U.S. government publications officially created to document the results of federally funded (U.S.) R&D were the technical reports first published by the National Advisory Committee for Aeronautics (NACA) in 1917.

Auger (1975) states that "the history of technical report literature in the U.S. coincides almost entirely with the development of aeronautics, the aviation industry, and the creation of the NACA, which issued its first report in 1917." In her study, *Information Transfer in Engineering*, Shuchman (1981) reports that 75% of the engineers she surveyed used technical reports; that technical reports were important to engineers doing applied work; and that aerospace engineers, more than any other group of engineers, referred to technical reports. However, in many of these studies, including Shuchman's, it is often unclear whether U.S. government technical reports, non-U.S. government technical reports, or both are included.

The U.S. government technical report is a primary means by which the results of federally funded R&D are made available to the scientific community and are added to the literature of

science and technology (President's Special Assistant for Science and Technology, 1962). McClure (1988) points out that "although the [U.S.] government technical report has been variously reviewed, compared, and contrasted, there is no real knowledge base regarding the role, production, use, and importance [of this information product] in terms of accomplishing this task." Our analysis of the literature supports the following conclusions reached by McClure:

- The body of available knowledge is simply inadequate and noncomparable to determine the role that the U.S. government technical report plays in transferring the results of federally funded R&D.

- Further, most of the available knowledge is largely anecdotal, limited in scope and dated, and unfocused in the sense that it lacks a conceptual framework.

- The available knowledge does not lend itself to developing "normalized" answers to questions regarding U.S. government technical reports.

THE TRANSFER OF FEDERALLY FUNDED AEROSPACE R&D AND THE U.S. GOVERNMENT TECHNICAL REPORT

Three paradigms -- appropriability, dissemination, and diffusion -- have dominated the transfer of federally funded (U.S.) R&D (Ballard, et al., 1989; Williams and Gibson, 1990). Whereas variations of them have been tried within different agencies, overall Federal (U.S.) STI transfer activities continue to be driven by a "supply-side," dissemination model.

The Appropriability Model

The **appropriability model** emphasizes the production of knowledge by the Federal government that would not otherwise be produced by the private sector and competitive market pressures to promote the use of that knowledge. This model emphasizes the production of basic research as the driving force behind technological development and economic growth and assumes that the Federal provision of R&D will be rapidly assimilated by the private sector. Deliberate transfer mechanisms and intervention by information intermediaries are viewed as unnecessary. Appropriability stresses the supply (production) of knowledge in sufficient quantity to attract potential users. Good technologies, according to this model, sell themselves and offer clear policy recommendations regarding Federal priorities for improving technological development and economic growth. This model incorrectly assumes that the results of federally funded R&D will be acquired and used by the private sector, ignores the fact that most basic research is irrelevant to technological innovation, and dismisses the process of technological innovation within the firm.

The Dissemination Model

The **dissemination model** emphasizes the need to transfer information to potential users and embraces the belief that the production of quality knowledge is not sufficient to ensure its fullest

use. Linkage mechanisms, such as information intermediaries, are needed to identify useful knowledge and to transfer it to potential users. This model assumes that if these mechanisms are available to link potential users with knowledge producers, then better opportunities exist for users to determine what knowledge is available, acquire it, and apply it to their needs. The strength of this model rests on the recognition that STI transfer and use are critical elements of the process of technological innovation. Its weakness lies in the fact that it is passive, for it does not take users into consideration except when they enter the system and request assistance. The **dissemination model** employs one-way, source-to-user transfer procedures that are seldom responsive in the user context. User requirements are seldom known or considered in the design of information products and services.

The Knowledge Diffusion Model

The **knowledge diffusion model** is grounded in theory and practice associated with the diffusion of innovation and planned change research and the clinical models of social research and mental health. Knowledge diffusion emphasizes "active" intervention as opposed to dissemination and access; stresses intervention and reliance on interpersonal communications as a means of identifying and removing interpersonal barriers between users and producers; and assumes that knowledge production, transfer, and use are equally important components of the R&D process. This approach also emphasizes the link between producers, transfer agents, and users and seeks to develop user-oriented mechanisms (e.g., products and services) specifically tailored to the needs and circumstances of the user. It makes the assumption that the results of federally funded R&D will be under utilized unless they are relevant to users and ongoing relationships are developed among users and producers. The problem with the knowledge diffusion model is that (1) it requires a large Federal role and presence and (2) it runs contrary to the dominant assumptions of established Federal R&D policy. Although U.S. technology policy relies on a "dissemination-oriented" approach to STI transfer, other industrialized nations, such as Germany and Japan, are adopting "diffusion-oriented" policies which increase the power to absorb and employ new technologies productively (Branscomb, 1991; Branscomb, 1992).

The Transfer of (U.S.) Federally-Funded Aerospace R&D

A model depicting the transfer of federally funded aerospace R&D through the U.S. government technical report appears in figure 1. The model is composed of two parts -- the **informal** that relies on collegial contacts and the **formal** that relies on surrogates, information producers, and information intermediaries to complete the "producer to user" transfer process.

When U.S. government (i.e., NASA) technical reports are published, the initial or primary distribution is made to libraries and technical information centers. Copies are sent to surrogates for secondary and subsequent distribution. A limited number of copies are set aside to be used by the author for the "scientist-to-scientist" exchange of information at the collegial level.

Surrogates serve as technical report repositories or clearinghouses for the producers and include the Defense Technical Information Center (DTIC), the NASA Center for Aero Space

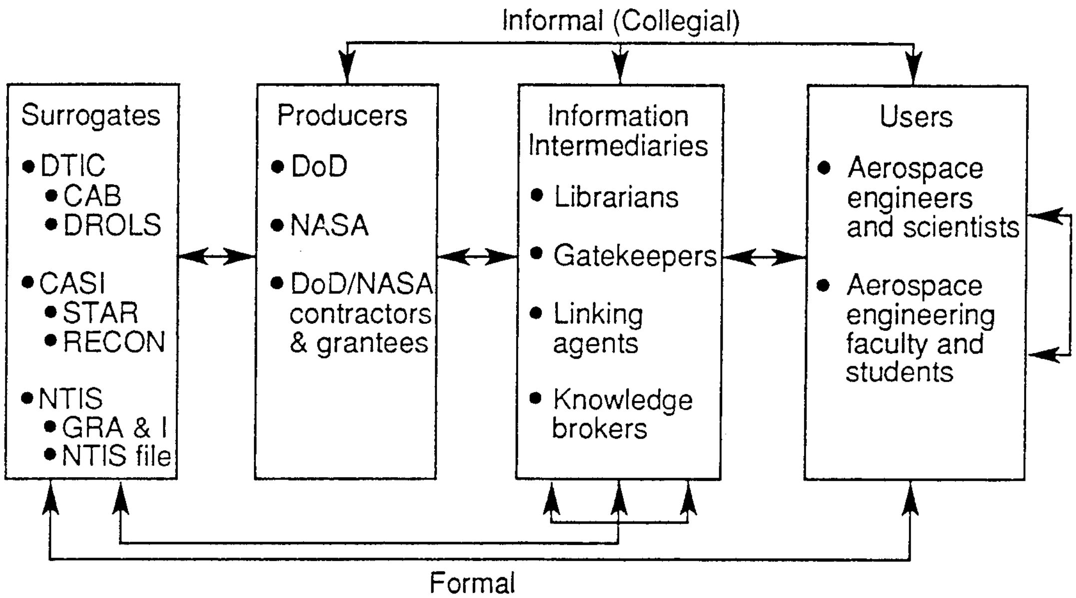

Figure 1. The U.S. Government Technical Report in
a Model Depicting the Dissemination of Federally Funded Aerospace R&D.

Information (CASI), and the National Technical Information Service (NTIS). These surrogates have created a variety of technical report announcement journals such as *CAB* (Current Awareness Bibliographies), *STAR* (Scientific and Technical Aerospace Reports), and *GRA&I* (Government Reports Announcement and Index) and computerized retrieval systems such as *DROLS* (Defense RDT&E Online System), *RECON* (REsearch CONnection), and NTIS *On-line* that permit online access to technical report data bases. Information intermediaries are, in large part, librarians and technical information specialists in academia, government, and industry. Those representing the producers serve as what McGowan and Loveless (1981) describe as "knowledge brokers" or "linking agents." Information intermediaries connected with users act, according to Allen (1977), as "technological entrepreneurs" or "gatekeepers." The more "active" the intermediary, the more effective the transfer process becomes (Goldhor and Lund, 1983). Active intermediaries move information from the producer to the user, often utilizing inter-personal (i.e., face-to-face) communication in the process. Passive information intermediaries, on the other hand, "simply array information for the taking, relying on the initiative of the user to request or search out the information that may be needed" (Eveland, 1987).

The overall problem with the total Federal STI system is that "the present system for transferring the results of federally funded STI is passive, fragmented, and unfocused;" effective knowledge transfer is hindered by the fact that the Federal government "has no coherent or systematically designed approach to transferring the results of federally funded R&D to the user" (Ballard, et al., 1986). In their study of issues and options in Federal STI, Bikson and her colleagues (1984) found that many of the interviewees believed "dissemination activities were afterthoughts, undertaken without serious commitment by Federal agencies whose primary

concerns were with [knowledge] production and not with knowledge transfer;" therefore, "much of what has been learned about [STI] and knowledge transfer has not been incorporated into federally supported information transfer activities."

Problematic to the **informal** part of the system is that knowledge users can learn from collegial contacts only what those contacts happen to know. Ample evidence supports the claim that no one researcher can know about or keep up with all the research in his/her area(s) of interest. Like other members of the scientific community, aerospace engineers and scientists are faced with the problem of too much information to know about, to keep up with, and to screen. Further, information is becoming more interdisciplinary in nature and more international in scope.

Two problems exist with the **formal** part of the system. First, the **formal** part of the system employs one-way, source-to-user transmission. The problem with this kind of transmission is that such formal one-way, "supply side" transfer procedures do not seem to be responsive to the user context (Bikson, et al., 1984). Rather, these efforts appear to start with an information system into which the users' requirements are retrofit (Adam, 1975). The consensus of the findings from the empirical research is that interactive, two-way communications are required for effective information transfer (Bikson, et al., 1984).

Second, the **formal** part relies heavily on information intermediaries to complete the knowledge transfer process. However, a strong methodological base for measuring or assessing the effectiveness of the information intermediary is lacking (Beyer and Trice, 1982). In addition, empirical data on the effectiveness of information intermediaries and the role(s) they play in knowledge transfer are sparse and inconclusive. The impact of information intermediaries is likely to be strongly conditional and limited to a specific institutional context.

According to Roberts and Frohman (1978), most Federal approaches to knowledge utilization have been ineffective in stimulating the diffusion of technological innovation. They claim that the numerous Federal STI programs are "highest in frequency and expense yet lowest in impact" and that Federal "information dissemination activities have led to little documented knowledge utilization." Roberts and Frohman also note that "governmental programs start to encourage utilization of knowledge only after the R&D results have been generated" rather than during the idea development phase of the innovation process. David (1986), Mowery (1983), and Mowery and Rosenberg (1979) conclude that successful [Federal] technological innovation rests more with the transfer and utilization of knowledge than with its production.

THE INFORMATION-SEEKING BEHAVIOR OF ENGINEERS

The information-seeking behavior of engineers and scientists has been variously studied by information and social scientists, the earliest studies having been undertaken in the late 1960s (Pinelli, 1991). The results of these studies have not accumulated to form a significant body of knowledge that can be used to develop a general theory regarding the information-seeking behavior of engineers and scientists. The difficulty in applying the results of these studies has

been attributed to the lack of a unifying theory, a standardized methodology, and the common definitions (Rohde, 1986).

Despite the fact that numerous "information use" studies have been conducted, the information-seeking behavior of engineers and information use in engineering are neither broadly known nor well understood. There are a number of reasons (Berul, et al., 1965): (1) many of the studies were conducted for narrow or specific purposes in unique environments such as experimental laboratories; (2) many, if not most, of them focused on scientists exclusively or engineers working in a research environment; (3) few studies have concentrated on engineers, especially engineers working in manufacturing and production; (4) from an information use standpoint, some engineering disciplines have yet to be studied; (5) most of the studies have concentrated on the users' use of information in terms of a library and/or specific information packages such as professional journals rather than how users produce, transfer, and use information; and (6) many of the studies, as previously stated, were not methodologically sophisticated and few included testable hypotheses or valid procedures for testing the study's hypotheses.

Further, we know very little about the diffusion of knowledge in specific communities such as aerospace. In the past 25 years, few studies have been devoted to understanding the information environment in which aerospace engineers and scientists work, the information-seeking behavior of aerospace engineers and scientists, and the factors that influence the use of federally funded aerospace STI. Presumably, the results of such studies would have implications for current and future aerospace STI systems and for making decisions regarding the transfer and use of federally funded aerospace STI.

RESULTS OF THE PHASE 1 SME MAIL SURVEY

This research was conducted as a Phase 1 activity of the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* Survey participants consisted of U.S. aerospace engineers and scientists who were on the SME mailing list of subscribers to *Manufacturing Engineering* (not necessarily members of the SME), and whose SIC code (i.e., 3921, 3924, and 3728) indicated they were employed in an aerospace organization. The survey instrument appears as Appendix B.

The Survey

The questionnaire used in this study was jointly prepared by the project team and representatives from the Indiana University Center for Survey Research (CSR). The survey was pretested on a group of aerospace engineers and scientists across the country. The Indiana University staff prepared an envelope for each individual that contained an 11-page questionnaire, two cover letters, and self-addressed, franked reply envelope. The cover letter provided a toll-free telephone number that respondents could call if they needed additional information. The envelopes were packaged and mailed to NASA Langley Research Center (LaRC) on May 24, 1994, for mailing. The envelopes were mailed from NASA LaRC on June 1, 1994.

Between June 1, 1994 and July 5, 1994, 193 completed questionnaires were returned. Fifty-five were returned with notes attached indicating that the survey was not applicable or that the person to whom the envelope had been addressed no longer worked at that company. On July 6, 1994, a follow-up postcard was prepared for the 1,252 individuals who had not yet responded to encourage them to complete and return the questionnaire. The postcards were packaged and mailed to NASA LaRC on July 6, 1994, and mailed from NASA LaRC on July 7, 1994. Included on the postcard was a toll-free telephone number for the CSR. From July 6, 1994 through July 25, 1994, 17 questionnaires were remailed as a result of telephone requests from potential respondents.

On July 28, 1994, the CSR staff prepared a follow-up mailing for the 1,106 individuals who had not responded to the first mailing or the postcard reminder. Each envelope in the mailing contained a reminder letter, a second copy of the questionnaire, and a self-addressed, franked reply envelope. The envelopes were prepared, packaged, and shipped to NASA LaRC on July 28, 1994.

By October 21, 1994, the survey cut-off date, 465 completed questionnaires had been received at the Indiana University CRS. The adjusted completion rate for the survey was 41%.

Data Collection and Analysis

A variation of Flanagan's (1954) critical incident technique was used to guide data collection. According to Lancaster (1978), the theory behind the critical incident technique is that it is much easier for people to recall accurately what they did on a specific occurrence or occasion than it is to remember what they do in general. Respondents were asked to categorize the most important job-related projects, task, or problem they had worked on in the past 6 months. The categories included (1) research, (2) design, (3) development, (4) manufacturing, (5) production, (6) quality assurance/control, (7) computer applications, (8) management, and (9) other.

Respondents were also asked to rate the amount of technical uncertainty and complexity they faced when they started their most important project, task, or problem. Technical uncertainty and complexity were measured on 5-point scales (1.0 = little uncertainty; 5.0 = great uncertainty; 1.0 = little complexity, 5.0 = great complexity). Survey participants were also asked to indicate whether they worked alone or with others in completing/solving the most important job-related project, task, or problem they had worked on in the past 6 months.

Technical uncertainty, complexity, and the importance of federally funded aerospace R&D were measured using ordinal scales. Hours spent communicating and the number of journal articles, conference-meeting papers, and U.S. government technical reports used were measured on an interval scale. Use of formal information sources and federally funded aerospace R&D were measured using a nominal scale. Data analysis was based on 465 responses, the total number of respondents received by the established cut-off date.

DESCRIPTIVE FINDINGS

Survey demographics for the 465 respondents appear in table 1. The following "composite" participant profile was developed for the respondents: works in industry (100%), has a bachelor's degree (45.9%), has an average of 16.5 years of work experience in aerospace, was educated as and works as an engineer (73.3%, 71.3%), works in manufacturing and production (51.0%), and is male (96.3%).

Project, Task, Problem

Survey participants were asked to categorize the most important job-related project, task, or problem they had worked on in the past 6 months. The categories and responses are listed in table 2. A majority of the job-related projects, tasks, and problems (47.1%) were categorized as manufacturing/production. About 12.5% and 9.9% of the job-related projects, tasks, and problems were categorized as development and management, respectively. Most respondents (73.4%) worked with others (did not work alone) in completing their most important job-related project, task, or problem.

Number of Groups and Group Size. On average, respondents worked with 3.0 groups; each group contained an average of 5.5 members (table 2). A majority of respondents (61.3%) performed engineering duties while working on their most important job-related project, task, or problem. About 26% performed management duties.

Project, Task, Problem Complexity and Uncertainty. Respondents were asked to rate the overall complexity of their most important job-related project, task, or problem. The mean complexity score was 3.85 (of a possible 5.00). Respondents were also asked to rate the amount of technical uncertainty they faced when they started their most important project, task, or problem. The average (mean) technical uncertainty score was 3.21 (of a possible 5.00).

Correlation coefficients (Pearson's *r*) **were calculated to compare (1) the overall "level of project, task, or problem complexity" and "technical uncertainty" and (2) the level of "project, task, or problem complexity by category" and "technical uncertainty."** The correlation coefficients appear in table 3. Positive and significant correlations were found for both comparisons. These findings support the hypothesis that there is a (positive) relationship between technical uncertainty and complexity.

Project, Task, or Problem and Information Use. Respondents were given a list of the following information sources used to complete their most important job-related project, task, or problem: (1) used personal stores of technical information, (2) spoke with coworkers inside the organization, (3) spoke with colleagues outside of the organization, (4) spoke with a librarian/technical information specialist, (5) used literature resources in the organization's library (6) searched (or had someone search for me) an electronic (bibliographic) data base. They were

Table 1. Survey Demographics
[n = 465]

Demographics	Percentage	Number
Do You Currently Work In:		
Industry	100.0	465
Is Any Of Your Work Funded By The Government:		
Yes	41.4	192
No	47.8	222
Your Highest Level Of Education:		
No Degree	24.6	114
Bachelor's Degree	45.9	213
Master's Degree	19.4	90
Doctorate	1.3	6
Other Type Of Degree	8.8	41
Your Years In Aerospace:		
0 years	1.1	5
1 Through 5 Years	13.2	66
6 Through 10 Years	23.1	107
11 Through 20 Years	31.1	144
21 Through 40 Years	30.3	140
41 Or More Years	1.1	5
Mean = 16.5 Years Median = 15.0 Years		
Your Education:		
Engineer	73.3	329
Scientist	2.4	11
Other	24.3	109
Your Primary Duties:		
Engineer	71.3	328
Scientist	1.1	5
Other	27.6	127
Is Your Work Best Classified As:		
Quality Control/Assurance	8.4	39
Research	2.6	12
Administration/Management	13.5	63
Design/Development	15.9	74
Manufacturing/Production	51.0	237
Service/Maintenance	1.9	9
Marketing/Sales	0.6	3
Private Consultant	0.6	3
Other	5.4	25
Your Gender:		
Female	3.7	17
Male	96.3	445

Table 2. Project, Task, or Problem Categorization

Factors	Percentage	Number
Categories Of Project, Task, Or Problem:		
Quality Assurance/Control	8.9	41
Research	4.5	21
Design	7.8	36
Development	12.5	58
Manufacturing/Production	47.1	218
Computer Applications	3.9	18
Management	9.9	46
Other	5.4	25
Worked On Project, Task Or Problem:		
Alone	26.6	123
With Others	73.4	340
Mean Number Of Groups = 3.0		
Mean Number of People/Group = 5.5		
Nature Of Duties Performed:		
Engineering	61.3	284
Science	2.2	10
Management	25.5	118
Other	11.0	51

Table 3. Correlation of Project Complexity and Technical Uncertainty by Type of Project, Task, or Problem

Complexity - Uncertainty Correlation	n	r
Overall**	462	0.27*
Quality Assurance/Control	41	0.37*
Research	21	0.30
Design	36	0.20
Development	58	0.24
Manufacturing/Production	217	0.24*
Management	46	0.38*
Computer Applications	18	0.25
Other	25	0.41*

* *r* values are statistically significant at $p \leq 0.05$.
** Overall mean complexity (uncertainty) score = 3.9 (3.2) out of a possible 5.00.

asked to identify the steps they followed to obtain needed information by sequencing these items (e.g., #1,#2,#3,#4, and #5). They were instructed to place an "X" beside the step(s) (i.e., information source) they did not use. The results appear in table 4.

Table 4. Information Sources Used to Solve Project, Task, or Problem

Information Source	Used First %	Used Second %	Used Third %	Used Fourth %	Used Fifth %	Used Sixth %	Not Used
Personal Store Of Technical Information	**54.1**	20.0	16.7	2.6	0.9	0.7	5.1
Spoke With Coworker(s) Inside The Organization	34.6	**46.7**	9.0	3.2	1.8	1.2	3.5
Spoke With Colleagues Outside Of The Organization	6.3	20.4	**37.1**	8.7	4.5	2.6	20.4
Used Literature Resources In My Organization's Library	4.7	5.4	14.8	**19.5**	**10.9**	4.4	40.2
Spoke With A Librarian/ Technical Information Specialist	0.0	3.6	5.9	10.8	9.0	**6.2**	64.4
Searched (Or Had Someone Search For Me) An Electronic (Bibliographic) Data Base	1.3	4.4	7.4	13.8	7.9	4.6	60.5

Use of Federally Funded Aerospace R&D. About 31.4% (412) of the participants used the results of federally funded aerospace R&D in their work. Respondents who used federally funded aerospace R&D in their work were given a list of 12 sources. They were asked to indicate how often they had learned about the results of federally funded aerospace R&D from each of the 12 sources. A 4-point scale (4.0 = frequently; 1.0 = never) was used to measure frequency. In table 5, the "frequently" and "sometimes" responses were combined to determine the overall use of the 12 sources. Of the six most frequently used sources, half involve interpersonal communication and half are formal (written) communication. Four of the five "federal initiatives" were the sources used least to learn about the results of federally funded aerospace R&D. NASA and DoD technical reports were the exception.

The respondents who reported using the results of federally funded aerospace R&D were asked if they used these results in completing the most important job-related project, task, or problem they had worked on in the past 6 months. The 18.6% (85) of respondents who answered "yes" were asked about the importance of these results in completing the project, task, or problem. A 5-point scale (1.0 = very unimportant, 5.0 = very important) was used to measure importance. The mean importance rating was 3.7. Almost one-half of those who used federally funded R&D (51 respondents) responded with an importance rating of "4" or "5". About 57% (46) of those who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem indicated that the results were published in either a NASA or DoD technical report.

Table 5. Sources Used to Learn About
the Results of Federally Funded Aerospace R&D
[n = 465]

Source	Percentage	Number
1. Professional And Society Journals	**66.7**	50
2. Coworkers Inside My Organization	**88.3**	68
3. Trade Journals	**64.9**	48
4. NASA And DoD Technical Reports	**53.4**	39
5. Colleagues Outside My Organization	**70.7**	53
6. NASA And DoD Contacts	40.8	31
7. Professional And Society Meetings	**45.9**	34
8. Searches of Computerized Data Bases	38.4	28
9. NASA And DoD Sponsored Conferences And Workshops	20.5	15
10. Visits To NASA And DoD Facilities	21.1	15
11. Publications Such As *STAR*	16.2	12
12. Librarians Inside My Organization	39.7	29

The respondents who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem were asked which problems, if any, they encountered in using these results (see table 6). Respondents were given a list of six problems from which to choose. About 46% indicated that the "time and effort it took to locate the results" was a problem. About 46% reported that the "time and effort it took to physically obtain the results" was a problem. About 36% indicated that "accuracy, precision, and reliability of the results" was a problem, and about 24% reported that "distribution limitations or security restrictions" constituted a problem. About 24/21% indicated that "organization or format"/"legibility or readability" of the results constituted a problem.

Technical Communications Practices

Data which describe factors concerning the production and use of technical information are summarized in table 7. Participants were asked to indicate the importance of communicating technical information effectively (e.g., producing written materials or oral discussions). A 5-point scale was used to measure importance (1.0 = very unimportant; 5.0 = very important).

Importance and Time Spent. The mean importance rating was 4.5; approximately 89% of respondents indicated that it was important to communicate technical information effectively. Respondents were also asked to report the total number of hours per week they had spent communicating technical information, both in written form and orally, during the past 6 months. Respondents reported spending slightly more time on producing oral discussions (an average of

Table 6. Problems Related to Use of Federally-Funded Aerospace R&D

Problem	Percentage	Number
Time And Effort To Locate Results	45.7	42
Time And Effort To Obtain Results	45.7	42
Accuracy, Precision And Reliability Of Results	35.9	33
Distribution Limitations Or Security Restrictions Of Results	23.9	22
Organization Or Format Of Results	23.9	22
Legibility Or Readability Of Results	20.7	19

12.6 hours/week) than written materials (an average of 10.5 hours/week). Approximately 67% of the respondents indicated that the amount of time they spent communicating technical information to others had increased over the past 5 years. About 5% indicated a decrease in the amount of time spent communicating technical information to others over the same period.

Respondents were also asked to report the total number of hours per week spent working with technical information, both written and oral, received from others in the past 6 months (see table 7). Respondents reported spending slightly more time working with written technical information received from others (an average of 10.4 hours/week) than with technical information received orally from others (an average of 8.2 hours/week). Approximately 68% of the respondents indicated that, as they have advanced professionally, the amount of time spent working with technical information received from others had increased. About 8% indicated a decrease in the amount of time they spent working with technical information when compared with 5 years ago.

Collaborative Writing. An attempt was made to determine the amount of writing in U. S. aerospace that is collaborative. Survey participants were asked to indicate the percentage of their written technical communications in the past 6 months that involved writing alone, with one other person, with a group of two to five people, and with a group of more than five people. About 40% of the survey respondents indicated that about 100% of the written technical communications they prepared involved writing alone. [The mean percent was ($\bar{X}$ = 76.0) and the median percent was 90.0.] About 83% indicated that their written technical communications involved writing with one other person. [The mean percent was ($\bar{X}$ = 18.8) and the median percent was 15.0.] About 66% indicated that their written technical communications involved writing with a group of two to five people. [The mean percent was ($\bar{X}$ = 14.0) and the median percent was 6.0.] About 29% indicated that their written technical communications involved writing with a group of more than five people. [The mean percent was ($\bar{X}$ = 4.1) and the median percent was 0.0.]

Table 7. Technical Communications: Importance, Time Spent, and Change Over Time

Communication And Receipt Of Information	Percentage	Number
Importance Of Communicating Technical Information:		
Unimportant	4.5	21
Neither important Nor Unimportant	6.0	28
Important	89.4	414
Mean = 4.5 Median = 5.0		
Time Spent Producing Written Technical Information:		
0 Hours Per Week	1.6	7
1 Through 5 Hours Per Week	33.8	151
6 Through 10 Hours Per Week	35.5	158
11 Through 15 Hours Per Week	8.4	38
16 Through 20 Hours Per Week	11.4	51
21 Or More Hours Per Week	8.9	41
Mean = 10.5 Median = 8.0		
Time Spent Communicating Technical Information Orally:		
0 Hours Per Week	0.7	3
1 Through 5 Hours Per Week	23.0	99
6 Through 10 Hours Per Week	34.8	150
11 Through 15 Hours Per Week	11.6	50
16 Through 20 Hours Per Week	17.2	74
21 Or More Hours Per Week	12.6	55
Mean = 12.6 Median = 10.0		
Change Over Past 5 Years In The Amount Of Time Spent Communicating Technical Information To Others:		
Increased	66.6	307
Stayed The Same	28.2	130
Decreased	5.2	24
Time Spent Working With Written Technical Information Received From Others:		
0 Hours Per Week	1.3	6
1 Through 5 Hours Per Week	41.3	188
6 Through 10 Hours Per Week	29.3	134
11 Through 15 Hours Per Week	7.9	36
16 Through 20 Hours Per Week	10.5	48
21 Or More Hours Per Week	9.5	44
Mean = 10.4 Median = 8.0		
Time Spent Working with Technical Information Received Orally From Others:		
0 Hours Per Week	1.2	5
1 Through 5 Hours Per Week	52.1	221
6 Through 10 Hours Per Week	28.2	120
11 Through 15 Hours Per Week	6.7	28
16 Through 20 Hours Per Week	7.2	31
21 Or More Hours Per Week	4.4	19
Mean = 8.2 Median = 5.0		
Professional Advancement And Changes In Amount Of Time Spent Working With Technical Information Received From Others:		
Increased	68.3	314
Stayed The Same	23.5	108
Decreased	8.3	38

Survey participants who write collaboratively were asked if they find writing as part of a group more or less productive (i.e., producing more written products or producing better written products) than writing alone. The responses appear in table 8. Overall, slightly more of the respondents indicated that writing with a group is more productive than writing alone. About 42% indicated that a group is more productive and about 37% indicated that a group is less productive. About 21% indicated that a group is about as productive as writing alone.

Table 8. Influence of Group Participation on Writing Productivity

How Productive	Percentage	Number
A Group Is More Productive Than Writing Alone	42.2	142
A Group Is About As Productive As Writing Alone	20.6	64
A Group Is Less Productive Than Writing Alone	37.2	129

Survey participants were asked if, during that 6 month period, they had worked with the same group of people when producing written technical communications. About 60% (161 respondents) indicated "yes" they had worked with the same group, and about 34% indicated that they had worked with various groups. Of those who indicated that they had worked in the same group, these respondents were asked how many people were in the group. About 74% (118 respondents) indicated a group size of 2-5 people and about 13% (21 respondents) indicated a group size of 6-10 people. The mean number of people in the group was $\bar{X} = 4.6$ and the median was 3.0.

Those 106 respondents who indicated "no" meaning that they did not work with the same group during the past 6 months were asked with about how many groups they had worked. About 25% (25 respondents) reported working with 2 groups, about 32% (32 respondents) reported working with 3 groups, about 17% (17 respondents) reported working with 4 groups, about 7% (7 respondents) reported working with 5 groups, and about 9% (9 respondents) reported working with 6-10 groups. The average (mean) number of groups was $\bar{X} = 3.6$ and the median number of groups was 3.0. The number of people in each group varied. About 75% of the respondents reported working with a group of 2-5 people and about 21% reported working with a group of 6-10 people. The average (mean) number of people per group was $\bar{X} = 4.5$ and the median number of people per group was 4.0.

<u>Technical Information Products Produced</u>. Survey participants were given a list of technical information products. They were asked to indicate the number of these products they had written or otherwise prepared in the past 6 months and if those products had been written or prepared as part of a group. The 10 most frequently produced (alone) technical information products appear in table 9.

Survey participants were also asked to indicate the number of these products they had written or otherwise prepared in the past 6 months as part of a group. The 10 most frequently prepared (as part of a group) technical information products appear in table 10. Data shown in table 10

include the number of products produced (mean and median) and the average (mean and median) numbers of people per group.

Table 9. Technical Information Products Written or Produced Alone in the Past 6 Months

Products	Mean ($\bar{X}$)	Median
Memoranda	21.5	12.0
Letters	16.9	10.0
Drawings/Specifications	21.7	10.0
DoD Technical Reports	1.9	0.0
Audio/Visual Materials	7.9	4.0
In-house Technical Reports	8.8	3.0
Computer Program Documentation	10.7	2.0
Conference/Meeting Papers	6.8	2.0
Technical Talks/Presentations	6.2	3.0
Technical Proposals	7.6	3.0

A comparison of the data contained in tables 9 and 10 reveals more similarities than differences. The production numbers vary somewhat but the products included on both lists (products produced alone or as part of a group) are essentially identical. With the exception of the "group size" for technical proposals, the average numbers of people per group for the various products produced are fairly similar in size.

Survey participants were given a list of technical information products. They were asked to indicate approximately how many times in the past 6 months they had used each of them. The 10 most frequently used technical information products appear in table 11. A comparison of the data contained in tables 9 (production) and 11 (use) reveals two differences. First, on average, more products are used than are produced. Second, there are slight differences in the types or kinds of products produced and used.

Technical Information Products -- Use, Importance, and Frequency of Use

Survey participants were asked several questions designed to obtain a greater understanding of the factors affecting the use of technical reports. In this study, technical reports were placed within the context of two technical information products: conference/meeting papers and journal articles. DoD, in-house, and NASA technical reports were included in this study.

Use. Survey participants were asked if they used the aforementioned technical information products in performing their present professional duties. Table 12 includes data regarding use.

Table 10. Technical Information Products Written or Produced as Part of a Group in the Past 6 Months

Information Products	In a Group		Average Number of People Per Group	
	Mean ($\bar{X}$)	Median	Mean ($\bar{X}$)	Median
Drawings/Specifications	12.6	4.0	3.9	3.0
Letters	7.2	2.0	3.6	2.0
Memoranda	6.6	3.0	3.8	3.0
Audio/Visual Material	5.1	3.0	4.7	4.0
Conference/Meeting Papers	3.2	2.0	4.7	3.0
In-house technical Reports	6.3	2.0	3.8	3.0
Technical Talks/Presentations	3.4	3.0	4.8	4.0
Computer Program Documentation	3.8	1.0	4.6	3.0
Technical Manuals	3.9	1.0	4.8	4.0
Technical Proposals	7.2	3.0	4.6	4.0

Table 11. Technical Information Product Used in the Past 6 Months

Information Products	Mean ($\bar{X}$)	Median
Drawings/Specifications	80.2	25.0
Memoranda	32.4	15.0
Letters	21.3	10.0
Trade/Promotional Literature	17.3	6.0
Technical Manuals	20.3	6.0
Abstracts	3.9	2.0
Audio/Visual Materials	16.4	5.0
Computer Program Documentation	21.0	6.0
Technical Proposals	8.1	3.0
Technical Talks/Presentations	6.7	4.0

Table 12. Technical Information Products Used

Information Products	Percentage	Number
Conference/Meeting Papers	62.7	271
Journal Articles	72.0	122
In-house Technical Reports	83.3	369
DoD Technical Reports	34.6	143
NASA Technical Reports	22.7	92

Importance. Survey participants were asked "how important is it for you to use the aforementioned technical information products in performing your present professional duties?" Table 13 includes data regarding the importance of use technical information products. A 5-point scale (1.0 = very unimportant; 5.0 = very important) was used to measure importance.

Table 13. Importance of Technical Information Products

Information Products	Mean ($\bar{X}$) Importance	Number
Conference/Meeting Papers	2.9	443
Journal Articles	3.0	444
In-house Technical Reports	3.7	451
DoD Technical reports	2.3	427
NASA Technical reports	2.1	416

Approximately 37% (163 respondents) indicated that the use of conference/meeting papers was "very or somewhat"important to their work. Approximately 36% (160 respondents) indicated that the use of journal articles was "very or somewhat" important to their work. Approximately 64% (290 respondents) indicated that in-house technical reports were "very or somewhat" important to their work. Approximately 22% (92 respondents) and 13% (56 respondents), respectively, indicated that DoD and NASA technical reports were "very or somewhat" important to their work.

Frequency of Use. Survey participants were asked to indicate the number of times each of the five technical information products had been used in a 6 month period in the performance of their professional duties (table 14). Data are presented both as means and medians. In-house technical reports were used ($\bar{X}$ = 12.56) to a much greater extent than were the other technical information products. Conference/meeting papers were used to a lesser extent ($\bar{X}$ = 8.51) followed by journal articles ($\bar{X}$ = 7.40), DoD ($\bar{X}$ = 4.47), and NASA technical reports ($\bar{X}$ = 1.89).

Table 14. Average Number of Times (Median) Technical Information Products Used in a 6 Month Period

Information Products	Mean ($\bar{X}$) Use	Median
Conference/Meeting Papers	8.51	3.00
Journal Articles	7.40	5.00
In-house Technical Reports	12.56	5.00
DoD Technical Reports	4.47	0.00
NASA Technical Reports	1.89	0.00

Technical Information Products -- Factors Affecting Use

Even if they did not use them, survey participants were asked if they were deciding whether or not to use any of the five technical information products in performing their present professional duties, how important each of the eight characteristics (factors) would be in making that decision. For example, respondents were asked to indicate how important the factor, "they are easy to physically obtain," would be in making a decision to use conference/meeting papers. A 5-point scale (1.0 = very unimportant; 5.0 = very important) was used to measure importance. The higher the number, the greater the influence of the factor on the use of conference/meeting papers. An overall mean ($\bar{X}$) rating was calculated. A mean ($\bar{X}$) rating for users and non-users of each product is presented.

<u>Conference/Meeting Papers</u>. The importance factor ratings for conference/meeting papers appear in table 15. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.5), (2) good technical quality ($\bar{X}$ = 4.3), (3) comprehensive data and information ($\bar{X}$ = 4.3), (4) easy to use or read ($\bar{X}$ = 4.1), and (5) easy to physically obtain ($\bar{X}$ = 3.9).

Table 15. Factors Affecting the Use of Conference/Meeting Papers

Factors	User Rating ($\bar{X}$) n = 268	Non-User Rating ($\bar{X}$) n = 154	Overall Rating ($\bar{X}$) n = 422
Are Easy To Physically Obtain	4.0	3.9	3.9
Are Easy To Use Or Read	4.1	4.0	4.1
Are Inexpensive	3.5	3.7	3.6
Have Good Technical Quality	4.5	4.2	4.3
Have Comprehensive Data And Information	4.5	4.1	4.3
Are Relevant To My Work	4.6	4.5	4.5
Can Be Obtained At A Nearby Location Or Source	3.7	3.8	3.7
Had Good Prior Experiences Using Them	3.5	3.4	3.4

<u>Journal Articles</u>. The importance factor ratings for journal articles appear in table 16. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.4), (2) good technical quality ($\bar{X}$ = 4.3), (3) comprehensive data and information ($\bar{X}$ = 4.3), (4) easy to use or read ($\bar{X}$ = 4.1), and (5) easy to physically obtain ($\bar{X}$ = 3.9).

Table 16. Factors Affecting the Use of Journal Articles

Factors	User Rating ($\bar{X}$) n = 310	Non-User Rating ($\bar{X}$) n = 114	Overall Rating ($\bar{X}$) n = 424
Are Easy To Physically Obtain	4.0	3.7	3.9
Are Easy To Use Or Read	4.1	4.0	4.1
Are Inexpensive	3.6	3.4	3.6
Have Good Technical Quality	4.4	4.1	4.3
Have Comprehensive Data And Information	4.4	4.1	4.3
Are Relevant To My Work	4.5	4.2	4.4
Can Be Obtained At A Nearby Location Or Source	3.7	3.5	3.6
Had Good Prior Experiences Using Them	3.4	3.3	3.4

In-House Technical Reports. The importance factor ratings for in-house technical reports appear in table 17. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.5), (2) good technical quality ($\bar{X}$ = 4.4), (3) comprehensive data and information ($\bar{X}$ = 4.4), (4) easy to use or read ($\bar{X}$ = 4.2), and (5) easy to physically obtain ($\bar{X}$ = 4.0).

DoD Technical Reports. The importance factor ratings for DoD technical reports appear in table 18. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.3), (2) good technical quality ($\bar{X}$ = 4.2), (3) comprehensive data and information ($\bar{X}$ = 4.2), (4) easy to use or read ($\bar{X}$ = 4.0), and (5) easy to physically obtain ($\bar{X}$ = 3.9).

Table 17. Factors Affecting the Use of In-house Technical Reports

Factors	User Rating ($\bar{X}$) n = 359	Non-User Rating ($\bar{X}$) n = 66	Overall Rating ($\bar{X}$) n = 425
Are Easy To Physically Obtain	4.0	3.9	4.0
Are Easy To Use Or Read	4.2	4.1	4.2
Are Inexpensive	3.1	3.6	3.2
Have Good Technical Quality	4.5	4.2	4.4
Have Comprehensive Data And Information	4.4	4.1	4.4
Are Relevant To My Work	4.6	4.4	4.5
Can Be Obtained At A Nearby Location	3.7	3.7	3.7
Had Good Prior Experiences Using Them	3.5	3.5	3.5

Table 18. Factors Affecting the Use of DoD Technical Reports

Factors	User Rating ($\bar{X}$) n = 140	Non-User Rating ($\bar{X}$) n = 245	Overall Rating ($\bar{X}$) n = 385
Are Easy To Physically Obtain	4.0	3.8	3.9
Are Easy To Use Or Read	4.2	3.9	4.0
Are Inexpensive	3.5	3.5	3.5
Have Good Technical Quality	4.5	4.1	4.2
Have Comprehensive Data And Information	4.5	4.1	4.2
Are Relevant To My Work	4.5	4.3	4.3
Can Be Obtained At A Nearby Location Or Source	3.6	3.6	3.6
Had Good Prior Experiences Using Them	3.5	3.3	3.4

NASA Technical Reports. The importance factor ratings for NASA technical reports appear in table 19. The factors exerting the greatest influence on use were (1) relevant to my work ($\bar{X}$ = 4.2), (2) good technical quality ($\bar{X}$ = 4.2), (3) comprehensive data and information ($\bar{X}$ = 4.1), (4) easy to use or read ($\bar{X}$ = 3.9), and (5) easy to physically obtain ($\bar{X}$ = 3.8).

Table 19. Factors Affecting the Use of NASA Technical Reports

Factors	User Rating ($\bar{X}$) n = 87	Non-User Rating ($\bar{X}$) n = 288	Overall Rating ($\bar{X}$) n = 375
Are Easy To Physically Obtain	4.0	3.7	3.8
Are Easy To Use Or Read	4.2	3.9	3.9
Are Expensive	3.5	3.5	3.5
Have Good Technical Quality	4.6	4.0	4.2
Having Comprehensive Data And Information	4.6	4.0	4.1
Are Relevant To My Work	4.5	4.2	4.2
Can Be Obtained At A Nearby Location Or Source	3.6	3.5	3.5
Had Good Prior Experiences Using Them	3.5	3.3	3.3

Use and Importance of Computer and Information Technology

Survey participants were asked if they use computer technology to prepare (written) technical communications. Almost all (95.3%) (443) of the survey respondents use computer technology to prepare (written) technical information. About 39.6% (184) of the respondents "always" use computer technology to prepare (written) technical information. About 98% (456) indicated that computer technology had increased their ability to communicate technical information. About 76% (353) of the respondents stated that computer technology had increased their ability to communicate technical information "a lot".

From a prepared list, survey respondents were asked to indicate which computer software they used to prepare written technical communication (table 20). Word processing software was used most frequently by survey respondents, followed by spelling checkers, business graphics, grammar and style checkers, and a thesaurus. Outliners and prompters and desktop publishing computer software were "least frequently" used to prepare written technical communication.

Table 20. Use of Computer Software to Prepare Written Technical Communication

Software	Percentage	Number
Word Processing	**96.1**	415
Outliners And Prompters	24.7	68
Grammar And Style Checkers	64.1	216
Spelling Checkers	**88.1**	353
Thesaurus	61.2	200
Business Graphics	69.3	232
Scientific Graphics	60.4	198
Desktop Publishing	46.3	145

Survey respondents were also given a list of information technologies and asked, "How do you view your use of the following information technologies in communicating technical information?" Their choices included "already use it"; "don't use it, but may in the future"; and "don't use it and doubt if I will". (See table 21.) The aerospace engineers and scientists in this study use a variety of information technologies. The percentages of "I already use it" responses ranged from a high of 95% (FAX and TELEX) to a low of 11% (motion picture films).

A list, in descending order, follows of the information technologies most frequently used.

FAX or TELEX	95%
Electronic Data Bases	70
Electronic Mail	62
Electronic Networks	63
Videotape	58

A list, in descending order, follows of the information technologies "that are not currently being used but may be used in the future."

Laser Disk/Video Disk/CD-ROM	56%
Video Conferencing	53
Electronic Bulletin Boards	49
Micrographics and Microforms	45
Desktop/Electronic Publishing*	41
Computer Cassettes/Cartridge Tapes*	41

* Indicates a tie.

Table 21. Use, Nonuse, and Potential Use of Information Technologies

Information Technologies	Already Use It		Don't Use It, But May In Future		Don't Use It, And Doubt If Will	
	%	(n)	%	(n)	%	(n)
Audio Tapes And Cassettes	31.0	132	27.5	117	41.5	177
Motion Picture Films	11.4	47	26.5	109	62.1	256
Videotape	58.4	251	28.6	123	13.0	56
Desktop/Electronic Publishing	48.9	206	41.3	174	9.7	41
Computer Cassettes/Cartridge Tapes	33.7	139	41.3	170	25.0	103
Electronic Mail	63.2	278	31.4	138	5.5	24
Electronic Bulletin Boards	34.1	142	48.8	203	17.1	71
FAX or TELEX	94.7	427	4.2	19	1.1	5
Electronic Data Bases	69.7	295	25.1	106	5.2	22
Video Conferencing	29.7	124	53.2	222	17.0	71
Micrographics And Microforms	31.8	130	45.0	184	23.2	95
Laser Disk/Video Disk/CD-ROM	27.4	113	56.3	232	16.3	67
Electronic Networks	62.8	268	29.5	126	7.7	33

Use and Importance of Electronic Networks

Survey participants were asked if the use electronic networks in their workplace in performing their present duties. About 73.9% of the respondents use electronic networks in performing their present duties and about 26.2% either do not use (14.4%), or do not have access to (11.8%) electronic networks. Survey respondents used electronic networks an average of 14.3 hours per week. (See table 22.)

Table 22. Use of Electronic Networks in One Week

Use		Percentage	Number
0 Hours		2.1	7
10 Hours		53.3	180
11 - 25 Hours		24.7	83
26 - 50 Hours		19.1	64
51 Or More Hours		0.9	3
Mean	14.3		
Median	10.0		

Respondents who use them were also asked to rate the importance of electronic networks in performing their present duties (table 23). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. About 80% of the respondents rated electronic networks important. About 14% rated them neither important nor unimportant, and about 7% rated electronic networks as very unimportant.

Table 23. Importance of Electronic Networks

Importance	Percentage	Number
Very Important	79.6	270
Neither Important Nor Unimportant	13.6	46
Very Unimportant	6.8	23

Respondents were asked how they accessed electronic networks (table 24): mainframe terminal, personal computers, and workstations. Access via personal computer (72%) was most frequently reported. Access via mainframe terminal and workstation was reported by less than 50% of the survey respondents.

Table 24. How Electronic Networks are Accessed

Access	%	(n)
Mainframe Terminal	47.8	165
Personal Computer	72.2	249
Workstation	42.6	147

Respondents using them were asked to indicate the purpose(s) for which they used electronic networks (table 25). Survey respondents indicated that information search and retrieval (79.6%) electronic mail (74.5%), log on to remote computers (59.5%), connect to geographically distant sites (53.1%), and accessing/searching the library's catalog (52.0%) represented their greatest use of electronic networks. Also noticeable is the lack of electronic network use for controlling remote equipment, acquiring (ordering) documents from the library, and searching (bibliographic) data bases.

Table 25. Use of Electronic Networks for Specific Purposes

Purpose	Percentage	Number
Connect To Geographically Distant Sites	53.1	165
Electronic Mail	74.5	243
Electronic Bulletin Boards Or Conferences	42.4	129
Log On To Remote Computers	59.5	188
Control Remote Equipment	34.1	103
Access/Search The Library's Catalog	52.5	165
Order Documents From The Library	36.2	110
Search Electronic (Bibliographic) Data Bases	39.3	119
Information Search And Data Retrieval	79.6	257
Prepare Scientific And Papers With Colleagues At Geographically Distant Sites	20.1	61

Survey participants who used electronic networks were asked to identify the groups with whom they exchanged messages or files (table 26). About three-quarters of the survey respondents used electronic networks to exchange files with members of their own work group, others in their organization but not in their work group, and people outside their organization.

Table 26. Use of Electronic Networks to Exchange Messages or Files

Exchange With --	Percentage	Number
Members Of Own Work Group	78.4	257
Others In Your Organization But Not In Your Work Group	75.2	248
Others In Your Organization, Not In Your Work Group, At A Geographically Different Site	52.8	169
People Outside Your Work Group	71.0	233

Use and Importance of Libraries/Technical Information Centers

Almost all of the survey respondents indicated that their organization has a library/technical information center. About 47% of the survey respondents indicated that the library/technical information center was located in the building where they worked. About 37% of the respondents indicated that the library/technical information center was located outside the building in which they worked. Sixteen percent of the respondents reported that their organization did not have a library/technical information center.

For 33% of the respondents, the library/technical information center was located 1 mile or less from where they worked. For about 67% of the respondents, the library/technical information center was located more than one mile from where they worked.

Survey respondents were also asked if the proximity of their work setting (e.g., office to their organization's library/technical information center) affected their use of that facility (table 27). The importance of proximity was measured on a 5-point scale with 1 = unimportant and 5 = very important. About 39% of the respondents indicated that proximity was "not at all" important. About 29% indicated that proximity was neither important nor unimportant. Thirty-two percent of the respondents indicated that proximity was very important. Overall, survey respondents were about equally divided on the extent to which proximity of the work setting to the library/technical information center influence its use.

Respondents were also asked to rate the importance of the organization's library/technical information center in terms of performing their professional duties. Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important (see table 28). About 56% of the aerospace engineers and scientists in the study indicated that their organization's library/technical information center was important or very important in performing their present professional duties. Approximately 24% of the survey respondents indicated that their library was neither important nor unimportant to performing their present professional duties. About 20% of respondents indicated that their organization's library/technical information center was very unimportant to performing their present professional duties.

Table 27. The Influence of Proximity of the Organization's Library/Technical Information Center on Use

Proximity	Percentage	Number
Not At All Important	39.4	117
Neither Important Nor Unimportant	28.6	85
Very Important	32.0	95
Mean 2.8		
Median 3.0		

Table 28. Importance of the Organization's Library/Technical Information Center on Use

Importance	Percentage	Number
Not At All Important	55.9	166
Neither Important Nor Unimportant	23.9	71
Very Important	20.2	60

Survey respondents were asked to report the number of times they had used their organization's library/technical information center in the past 6 months (see table 29). On average, survey respondents used their library/technical information center about 12 times in the past 6 months. About 24% of the survey respondents did not use their library's library/technical information center in the past 6 months. Reasons for not using the organization's library/technical information center are shown in table 30. About 87% of the respondents were more easily met some other way. About 42% indicated that they had no information needs. About 34% indicated that the library did not have the information they needed.

Table 29. Use of the Organization's Library/Technical Information Center in the Past 6 Months

Visits	Percentage	Number
0 Times	23.8	91
1 - 5 Times	34.4	132
6 - 10 Times	13.3	51
11 - 25 Times	17.3	66
26 - 50 Times	7.4	28
51 - 94 Times	0.6	2
95 Or More Times	3.4	13
Mean 11.8		
Median 4.0		

Table 30. Reasons Respondents Did Not Use A Library During the Past 6 Months

Reason	Percentage	Number
I Had No Information Needs	**41.8**	82
My Information Needs Were More Easily Met Some Other Way	86.6	175
Tried The Library Once Or Twice Before But I Couldn't Find The Information I Needed	11.0	20
The Library Staff Is Not Cooperative Or Helpful	3.8	7
The Library Staff Does Not Understand My Information Needs	7.6	14
The Library Did Not Have The Information I Need	**33.9**	63
I Have My Own Personal Library And Do Not Need Another Library	26.9	50
The Library Is Too Slow In Getting The Information I Need	15.3	28
We Have To Pay To Use The Library	1.1	2
We Are Discouraged From Using The Library	1.1	2

FINDINGS

Readers should note that the data contained in this report reflect the responses of U.S. aerospace engineers and scientists who were on the Society of Manufacturing Engineers (SME) mailing list (not necessarily members of the SME). The results, therefore, are not generalizable to (1) the membership of the SME, (2) all U.S. aerospace engineers and scientists working in manufacturing/production, or (3) all U.S. aerospace engineers and scientists. Further, the survey was conducted during the time when the U.S. aerospace industry was undergoing significant changes. Many organizations had merged or had gone out of business. Many members of the sample had left their jobs.

1. The "average" participant works in industry (100%), has a bachelor's degree (46.7%), has an average of 16.5 years of work experience in aerospace, was educated as and works as an engineer (73%, 71%), and works in manufacturing/production (51%), and is male (96%).

2. Their most important job-related project, task, or problem worked on in the past 6 months was categorized as manufacturing/production (47%); 73% of the participants worked on this project, task, or problem with others. The mean number of groups involved was 3.0, and the mean number of people in a work group was 5.5. Engineering duties predominated (61%) followed by management duties (26%) in the completion of the most important job-related project, task, or problem worked on in the past 6 months.

3. A positive and significant correlation was found between the overall complexity and technical uncertainty of the most important job-related project, task, or problem that respondents had worked on in the past 6 months.

4. To complete their most important job-related project, task, or problem, respondents first went to their personal stores of technical information (54%); next, spoke with coworker(s) inside the organization (47%); third, spoke with colleagues outside of the organization (37%); fourth, and fifth, used literature resources in the organization's library (20%); and sixth, spoke with a librarian/technical information specialist (6%). About 64% and 61%, respectively, did not speak to a librarian or search (or have searched) electronic data bases to complete their most important job-related project, task, or problem.

5. Approximately 31% of the respondents reported using the results of federally funded aerospace R&D in their work. Of the six sources most frequently used to find out about the results of federally funded aerospace R&D, half involve interpersonal communication and half are formal (written) communication. Four of five "federal initiatives" were the sources used least to learn about the results of federally funded aerospace R&D. DoD and NASA technical reports were the exception.

6. About 19% of the respondents had used the results of federally funded aerospace R&D to complete their most important job-related project, task, or problem during the last 6 months. About 50% of this group indicated that federally funded aerospace R&D was "important" or "very important" for completing this work. About 57% (46) of those who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem indicated that the results were published in either a NASA or DoD technical report.

7. Of the respondents who used the results of federally funded aerospace R&D in completing their most important job-related project, task, or problem, 46% indicated that the "time and effort it took to locate the results" was a problem, and 46% reported that the "time and effort it took to obtain the results" was a problem.

8. About 90% of the respondents indicated that it was important to communicate technical information effectively; respondents spent an average of 10.5 hours per week producing written material and 12.6 hours per week communicating information orally. Over the past 5 years approximately 67% have increased the amount of time they spend communicating information to others. Survey respondents reported spending an average of 10.4 hours per week working with written information received from others and an average of 8.2 hours per week working with information received orally from others. More than 68% of the respondents indicated that the amount of time they spend working with technical information received from others has increased as they have advanced professionally.

9. About 40% of the respondents reported that all of the written technical communications they prepared involved writing alone. About 83% indicated that their written technical communications involved writing with one other person. About 66% indicated that their written technical

communications involved writing with a group of two to five people. About 29% indicated that their written technical communications involved writing with a group of more than five people.

10. In terms of the perceived productivity of collaborative writing, slightly more of the respondents indicated that writing with a group is more productive than writing alone. About 42% indicated that a group is more productive and about 37% indicated that a group is less productive. About 21% indicated that a group is about as productive as writing alone.

11. A comparison of the technical information products produced and used reveals that on average, the survey respondents use more products than they produce. There are also slight differences in the types of technical information products produced and used.

12. Survey respondents were asked to indicate their use of and the importance to them of five technical information products. In-house technical reports were used most frequently ($\bar{X}$ = 12.6) and were rated most important ($\bar{X}$ = 3.7). DoD and NASA technical reports were used by about 35% and 25% of the respondents and were rated about equal in importance ($\bar{X}$ = 2.3, $\bar{X}$ = 2.1).

13. Both users and non-users of the five information products were asked to indicate about the importance of eight factors in deciding whether to use any of the five information products. Overall, the factors exerting the greatest influence on decisions to use products follow.

Conference/meeting papers -- (1) good technical quality, (2) relevant to my work, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

Journal articles -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

In-house technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

DoD technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

NASA technical reports -- (1) relevant to my work, (2) good technical quality, (3) comprehensive data and information, (4) easy to use or read, and (5) easy to physically obtain.

14. About 95% of the survey participants used computer technology to prepare written technical communications; about 98% of them indicated that computer technology had increase their ability to communicate technical information.

15. Word processing and spelling checkers were the computer software used most often in preparing written technical information.

16. FAX or TELEX, electronic data bases, electronic mail, electronic networks, and videotape were the information technologies used most frequently by survey respondents.

17. About 74% of the survey participants used electronic networks in performing their present professional duties; they use electronic networks an average of 14.3 hours per week; and about 80% rated them important in terms of performing their present professional duties.

18. About 70% of the respondents access electronic networks via personal computer; about 75% use electronic networks for electronic mail and to search and retrieve information and data; and about 78% use electronic networks to exchange messages and files with members of their own group.

19. Survey respondents (56%) indicated that the organization's library/technical information center was important in performing their present professional duties.

20. On average, survey respondents visited their organization's library/technical information center 11.8 times in a 6 month period; survey respondents were about equally divided as to whether proximity of the work setting to the organization's library/technical information center influenced its use.

21. The most common reasons for not using the organization's library/technical information center included "my information needs were more easily met some other way," "I had no information needs," and "the library did not have the information I needed."

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APPENDIX A: PROJECT FACT SHEET

NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT

Fact Sheet

The process of producing, transferring, and using scientific and technical information (STI), which is an essential part of aerospace research and development (R&D), can be defined as *Aerospace Knowledge Diffusion*. Studies tell us that timely access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills. These same studies indicate, however, that we know little about aerospace knowledge diffusion or about how aerospace engineers and scientists find and use STI. To learn more about this process, we have organized a research project to study knowledge diffusion. Sponsored by NASA and the Department of Defense (DoD), the *NASA/DoD Aerospace Knowledge Diffusion Research Project* is being conducted by researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, and Rensselaer Polytechnic Institute. This research is endorsed by several aerospace professional societies including the AIAA, RAeS, and DGLR and has been sanctioned by the AGARD and AIAA Technical Information Panels.

This 4-phase project is providing descriptive and analytical data about the flow of STI at the individual, organizational, national, and international levels. It is examining both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. Phase 1 investigates the information-seeking habits and practices of U.S. aerospace engineers and scientists, in particular their use of government-funded aerospace STI. Phase 2 examines the industry-government interface and emphasizes the role of the information intermediary in the knowledge diffusion process. Phase 3 concerns the academic-government interface and emphasizes the information intermediary-faculty-student interface. Phase 4 explores the information-seeking behaviors of non-U.S. aerospace engineers and scientists from Western European nations, India, Israel, Japan, and the former Soviet Union.

The results of this research project will help us to understand the flow of STI at the individual, organizational, national, and international levels. The findings can be used to identify and correct deficiencies; to improve access and use; to plan new aerospace STI systems; and should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. These results will contribute to increasing productivity and to improving and maintaining the professional competence of aerospace engineers and scientists. The results of our research are being shared freely with those who participate in the study.

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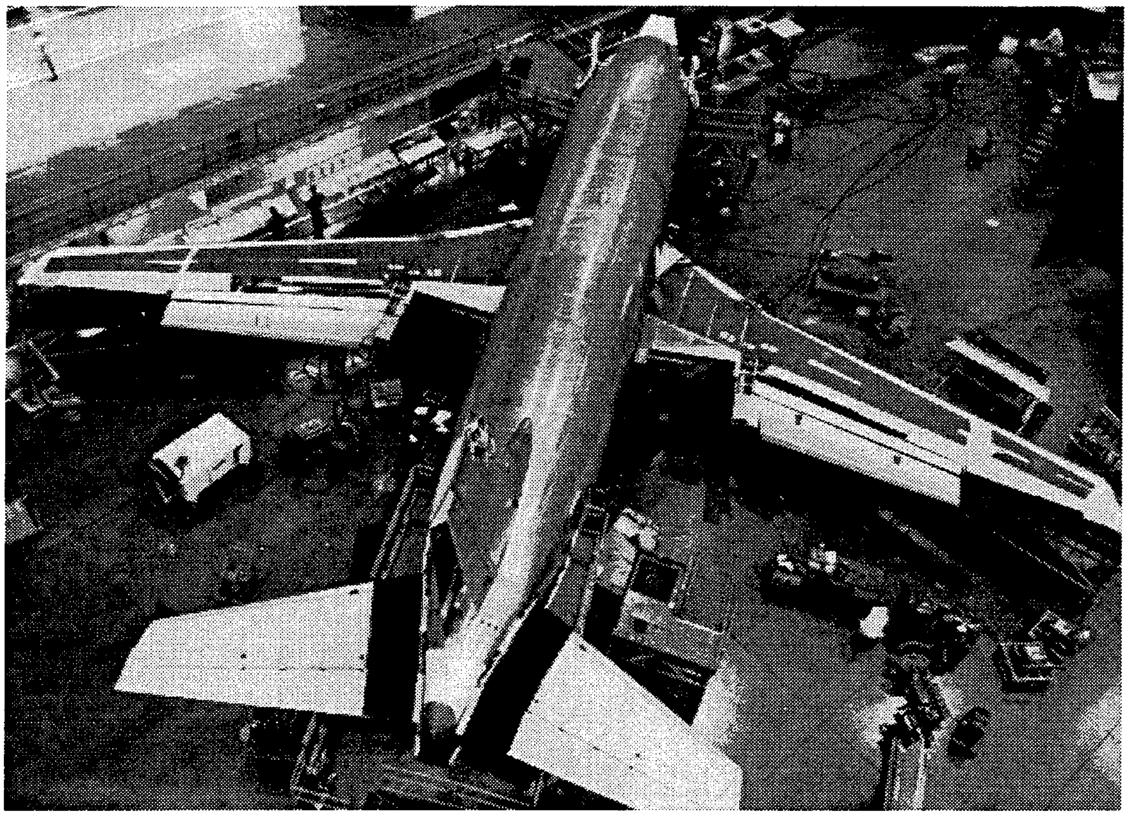
APPENDIX B: SURVEY INSTRUMENT

PHASE 1 OF THE
NASA/DOD AEROSPACE KNOWLEDGE
DIFFUSION RESEARCH PROJECT

Technical Communications in Aerospace: A Manufacturing and Production Perspective The SME Study



SPONSORED BY THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AND THE DEPARTMENT OF DEFENSE WITH THE COOPERATION OF INDIANA UNIVERSITY AND THE SOCIETY OF MANUFACTURING ENGINEERS (SME)

The first group of questions ask about your use of technical information.

1. In your work, how important is it for you to *communicate* (e.g., produce written materials or oral discussions) technical information *effectively*? (Circle number)

   Not at all important 1 2 3 4 5 Very Important

2. In the past 6 months, about how many hours did you spend each week communicating (*producing*) technical information?

   (Output) __________ hours per week writing
   __________ hours per week communicating orally

3. Compared to 5 years ago, how has the amount of time you spend *communicating* technical information changed? (Circle ONE number)

   1 Increased
   2 Stayed the same
   3 Decreased

4. In the past 6 months, about how many hours did you spend each week working with technical information *received from others*?

   (Input) __________ hours per week working with written information
   __________ hours per week receiving information orally

5. As you have advanced professionally, how has the amount of time you spend working with technical information *received from others* changed? (Circle ONE number)

   1 Increased
   2 Stayed the same
   3 Decreased

6. In the past 6 months, about what percentage of your written technical communications involved:

Writing alone	__________%	→ (If 100%, go to question 9.)
Writing with one other person	__________%	
Writing with a group of 2 to 5 people	__________%	
Writing with a group of more than 5 people	__________%	
	100 %	

7. In general, do you find writing as part of a group more or less productive (i.e., producing more written products or better written products) than writing alone? (Circle ONE number)

   1 A group is *less* productive than writing alone
   2 A group is *about* as productive as writing alone
   3 A group is *more* productive than writing alone
   4 Difficult to judge; no experience preparing technical information

8. In the past 6 months, did you work with the same group of people when producing written technical information? (Circle ONE number)

1 Yes ⟶ About how many people were in the group? number of people ________

2 No ⟶ With about how many groups did you work? number of groups ________

↓

About how many people were in each group? number of people ________

9. Approximately how many times in the past 6 months did you *write or prepare* the following alone or in a group? (If in a group, how many people were in each group?)

Times Wrote or Prepared in Past 6 Months

	Alone	In a Group	Average Number of People in Group
a. Abstracts	________	________	________
b. Journal Articles	________	________	________
c. Conference/Meeting Papers	________	________	________
d. Trade/Promotional Literature	________	________	________
e. Drawings/Specifications	________	________	________
f. Audio/Visual Materials	________	________	________
g. Letters	________	________	________
h. Memoranda	________	________	________
i. Technical Proposals	________	________	________
j. Technical Manuals	________	________	________
k. Computer Program Documentation	________	________	________
l. In-house Technical Reports	________	________	________
m. DoD Technical Reports	________	________	________
n. NASA Technical Reports	________	________	________
o. Technical Talks/Presentations	________	________	________

10. Approximately how many times in the past 6 months did you *use* the following as part of your professional duties?

	Times Used in Past 6 Months
a. Abstracts	________
b. Journal Articles	________
c. Conference/Meeting Papers	________
d. Trade/Promotional Literature	________
e. Drawings/Specifications	________
f. Audio/Visual Materials	________
g. Letters	________
h. Memoranda	________
i. Technical Proposals	________
j. Technical Manuals	________
k. Computer Program Documentation	________
l. In-house Technical Reports	________
m. DoD Technical Reports	________
n. NASA Technical Reports	________
o. Technical Talks/Presentations	________

Next, a few questions about computer use.

11. Do you use computer technology to prepare technical information? (Circle ONE number)

1	Always	Go to question 12
2	Usually	Go to question 12
3	Sometimes	Go to question 12
4	Never	Go to question 14

12. Has computer technology increased your ability to communicate technical information? (Circle ONE number)

1 Yes, a lot
2 Yes, a little
3 No

13. Do you use any of the following software to prepare written technical information? (Circle the appropriate number for each)

	Yes	No
Word processing packages	1	2
Outliners and prompters	1	2
Grammar and style checkers	1	2
Spelling checkers	1	2
Thesaurus	1	2
Business graphics	1	2
Scientific graphics	1	2
Desktop publishers	1	2

14. How do you view your USE of the following electronic/information technologies in communicating technical information? (Circle the appropriate number for each)

Information Technologies	Already Use	Don't use but may in the future	Don't use and doubt if I will
Audio tapes and cassettes	1	2	3
Motion picture films	1	2	3
Video tape	1	2	3
Desktop/electronic publishing	1	2	3
Computer cassette/cartridge tapes	1	2	3
Electronic mail	1	2	3
Electronic bulletin boards	1	2	3
FAX or TELEX	1	2	3
Electronic data bases	1	2	3
Video conferencing	1	2	3
Micrographics and microforms	1	2	3
Laser disc/video disc/CD-ROM	1	2	3
Electronic networks	1	2	3

15. At your workplace, do you use electronic networks in performing your present duties? (Circle ONE number)

1	Yes	→ Go to question 16
2	No	→ Go to question 21
3	No, because I do not have access to electronic networks	→ Go to question 21

16. At your workplace, how do you access electronic networks? (Circle all that apply)

1 By using a mainframe terminal
2 By using a personal computer
3 By using a workstation

17. How important is the use of electronic networks in performing your present duties? (Circle number)

Not at all important 1 2 3 4 5 Very Important

18. In the past week, about how many hours did you USE your electronic networks?

_________ Hours in the past week

19. Do you use electronic networks for the following purposes? (Circle appropriate number for each)

	Yes	No
To connect to geographically distant sites	1	2
For electronic mail	1	2
For electronic bulletin boards or conferencing	1	2
To log into remote computers for such things as computational analysis or to use design tools	1	2
To control remote equipment such as laboratory instruments or machine tools	1	2
To access/search a library catalog	1	2
To order documents from a library	1	2
To search electronic (bibliographic) data bases (e.g., Dialog)	1	2
For information search and data retrieval	1	2
To prepare scientific and technical papers with colleagues at geographically distant sites	1	2

20. Do you USE electronic networks to communicate with:

	Yes	No
Members of your work group	1	2
Other people in your organization at the SAME geographical site who are NOT in your work group	1	2
Other people in your organization at geographically **DIFFERENT** sites who are NOT in your work group	1	2
People outside your work group	1	2

We would also like to know about your use of a library or technical information center.

21. Does your organization/company have a library/technical information center? (Circle ONE number)

1 Yes, in my building ⟶ Go to question 22
2 Yes, but not in my building ________ miles ________ minute walk ⟶ Go to question 22
3 No ⟶ Go to question 26

22. In the past 6 months, how often did you USE your organization's library/technical information center?

________ Number of times in past 6 months

If "0" times or you did not use your organization's library, go to question 25.

23. To what extent does the proximity of your work setting (e.g., office) to your organization's library/technical information center affect your use of it? (Circle ONE number)

Not at all important 1 2 3 4 5 Very Important

24. In terms of performing your present professional duties, how important is your organization's library/technical information center? (Circle ONE number)

Not at all important 1 2 3 4 5 Very Important ⟶ Go to question 26

25. Which of the following statements describe your reasons for not using a library during the past 6 months? (Circle appropriate number for each)

	Yes	No
I had no information needs	1	2
My information needs were more easily met some other way	1	2
Tried the library once or twice before but I couldn't find the information I needed	1	2
The library staff is not cooperative or helpful	1	2
The library staff does not understand my information needs	1	2
The library did not have the information I needed	1	2
The library is too slow in getting the information I need	1	2
I have my own personal library and do not need another library	1	2
We have to pay to use the library	1	2
We are discouraged from using the library	1	2

Please tell us about your use of specific information sources.

26. Do you use the following information sources in performing your present professional duties? (Circle appropriate number for each)

	Yes	No
Conference/Meeting papers	1	2
Journal articles	1	2
Technical reports - In-house	1	2
Technical reports - DoD	1	2
Technical reports - NASA	1	2

27. In terms of performing your present professional duties, how important is each of the following information sources? (Circle appropriate number for each)

	Not at all Important				Very Important
Conference/Meeting papers	1	2	3	4	5
Journal articles	1	2	3	4	5
Technical reports - In-house	1	2	3	4	5
Technical reports - DoD	1	2	3	4	5
Technical reports - NASA	1	2	3	4	5

28. If you were deciding whether or not to use **conference/meeting papers** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

29. If you were deciding whether or not to use **journal articles** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

30. If you were deciding whether or not to use **in-house technical reports** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

31. If you were deciding whether or not to use **DoD technical reports** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

32. If you were deciding whether or not to use **NASA technical reports** in your work, how important would the following factors be? (Circle appropriate number)

	Not at all Important				Very Important
Are easy to physically obtain	1	2	3	4	5
Are easy to use or read	1	2	3	4	5
Are inexpensive	1	2	3	4	5
Have good technical quality	1	2	3	4	5
Have comprehensive data and information	1	2	3	4	5
Are relevant to my work	1	2	3	4	5
Can be obtained at a nearby location or source	1	2	3	4	5
Had good prior experience using them	1	2	3	4	5

Next, we would like to know about the work you do.

33. Think of the most important job-related project, task, or problem you have worked on in the past 6 months. Which category best describes this work? (Circle only ONE number)

    1 Research (either basic or applied)
    2 Design
    3 Development
    4 Manufacturing
    5 Production
    6 Quality Assurance/Control
    7 Computer Applications
    8 Management (e.g., planning, budgeting, and managing research)
    9 Other (specify): ______________________________

34. How would you describe the overall complexity of the technical project, task, or problem you categorized in Question 33? (Circle ONE number)

    Very Simple 1 2 3 4 5 Very Complex

35. How would you rate the amount of technical uncertainty that you faced when you started the technical project, task, or problem categorized in Question 33? (Circle ONE number)

    Little Uncertainty 1 2 3 4 5 Great Uncertainty

36. While you were involved in this technical project, task, or problem, did you work alone or with others?

    1 Alone
    2 With others ——→ In how many groups did you work? ________
    About how many people were in each group? ________

37. Which one of the following best describes the kinds of duties you performed while working on the technical project, task, or problem categorized in Question 33? (Circle ONE number)

    1 Engineering
    2 Science
    3 Management
    4 Other (specify): ______________________________

38. What steps did you follow to get the information you needed for this project, task, or problem? [Please sequence these items (e.g., #1, #2, #3) and put an X beside the steps you did not use.]

    ________ Used my personal store of technical information, including sources I keep in my office
    ________ Spoke with coworkers or people inside my organization
    ________ Spoke with colleagues outside my organization
    ________ Spoke with a librarian or technical information specialist
    ________ Searched (or had someone search for me) an electronic (bibliographic) data base in the library
    ________ Used literature resources (e.g., technical reports) found in my organization's library

    ________ Used none of the above steps

39. Do you USE the results of federally-funded aerospace R&D in your work? (Circle ONE number)

1 Yes 2 No

40. Did you USE the results of federally-funded aerospace R&D in completing the technical project, task, or problem you categorized in Question 33? (Circle ONE number)

1 Yes 2 No ⟶ Go to question 45

41. How important were the results of federally-funded R&D in completing the technical project, task, or problem you categorized in Question 33? (Circle ONE number)

Not at all important 1 2 3 4 5 Very Important

42. Were any of these results published in either a NASA or DoD technical report? (Circle ONE number)

1 Yes 2 No

43. From which of the following sources did you learn about/obtain the results of the federally-funded aerospace R&D you used in completing the technical project, task, or problem? (Circle appropriate number for each)

	Yes	No
Coworkers inside my organization	1	2
Colleagues outside my organization	1	2
NASA and DoD contacts	1	2
Publications such as NASA *STAR*	1	2
NASA and DoD sponsored and co-sponsored conferences and workshops	1	2
NASA and DoD technical reports	1	2
Professional and society journals	1	2
Librarians inside my organizations	1	2
Trade journals	1	2
Searches of computerized data bases	1	2
Professional and society meetings	1	2
Visits to NASA and DoD facilities	1	2

44. Which, if any, of the following problems were associated with using these results? (Check ALL that apply)

_________ The time and effort it took to locate the results
_________ The time and effort it took to physically obtain the results
_________ The accuracy, precision, and reliability of the results
_________ The legibility or readability of the results
_________ The organization or format of the results
_________ The distribution limitations or security restrictions of the results

We're asking a few questions for the SME.

45. Are you a member of the Society of Manufacturing Engineers (SME)? (Circle number)

1 Yes 2 No ⟶ Go to question 52

46. How were you first made aware of SME? (Circle ONE number)

1	Word-of-mouth	4	SME brochure/literature
2	School/student organization	5	SME seminars/conferences
3	Industry publications	6	Trade shows/expositions

47. Your **primary** reason for joining SME was? (Circle ONE number)

1	Career advancement	4	Peer pressure
2	Professional development	5	Other (specify): ________________________
3	Discounts		

48. Which of the following SME offerings/activities have you used/attended? (Check ALL that apply)

_____	Plant tours	_____	Professional contacts
_____	SME product discounts	_____	SME library and *INTIME*
_____	SME conferences/clinics/courses	_____	SME credit card service
_____	SME books/papers/videos	_____	SME sponsored health/life/auto insurance
_____	SME shows/expositions	_____	SME resume service
_____	SME *News*	_____	SME *On-line*
_____	SME Education Foundation	_____	SME technical referral data base
_____	SME local chapter meetings	_____	SME certification program
_____	SME *Manufacturing Engineering*	_____	Other (specify): ____________________________

49. Which three (3) of the following SME offerings/activities are **most important/least important** to you?

1	Plant tours	10	Professional contacts
2	SME product discounts	11	SME library and *INTIME*
3	SME conferences/clinics/courses	12	SME credit card service
4	SME books/papers/videos	13	SME sponsored health/life/auto insurance
5	SME shows/expositions	14	SME resume service
6	SME *News*	15	SME *On-line*
7	SME Education Foundation	16	SME technical referral data base
8	SME local chapter meetings	17	SME certification program
9	SME *Manufacturing Engineering*	18	Other (specify): ____________________________

Most Important:
Enter number of first choice: __________ **second choice:** _________ **third choice:** _________
Least Important:
Enter number of first choice: __________ **second choice:** _________ **third choice:** _________

50. Which features of SME *On-line* have you used? (Check ALL that apply)

1	Conference forums	5	Job applications programs
2	E-mail	6	Do not use SME *On-line*
3	Manufacturing technical interest areas	7	Do not have access to a computer/modem
4	National job posting service		

OVER ⟶

51. How would you prefer to receive information from SME? (Circle ONE number)

1 Word-of-mouth
2 Direct mail
3 Telemarketing
4 E-mail and electronic bulletin boards
5 Other (specify): ____________________

Survey Demographics

52. Gender:

1 Male
2 Female

53. Please indicate the highest college degree you hold.

1 No college degree
2 Bachelor's
3 Master's
4 Doctorate
5 Other (specify): ____________________

54. Years of aerospace work experience: ________ years

55. Which of the following best describes your primary professional duties? (Circle ONE number)

1 Research
2 Administration/Management
3 Quality Assurance/Control
4 Design/Development
5 Manufacturing/Production
6 Service/Maintenance
7 Marketing/Sales
8 Private Consultant
9 Other (specify): ____________________

56. Was your academic preparation as an: (Circle ONE number)

1 Engineer
2 Scientist
3 Other (specify): ______________________________

57. In your present job, do you consider yourself primarily an: (Circle ONE number)

1 Engineer
2 Scientist
3 Other (specify): ______________________________

58. Is any of your current work funded by the federal government? (Circle ONE number)

1 Yes 2 No 3 Don't know

THANK YOU!

Mail to:

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REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 1994	Technical Memorandum

4. TITLE AND SUBTITLE
The Technical Communications Practices of U.S. Aerospace Engineers and Scientists: Results of the Phase 1 SME Mail Survey*

5. FUNDING NUMBERS
WU 505-90

6. AUTHOR(S)
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7. PERFORMING ORGANZATION NAME(S) AND ADDRESS(ES)
NASA Langley Research Center
Hampton, VA 23681-0001

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORIING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
NASA TM-109169

11. SUPPLEMENTARY NOTES
*Report number 31 under the NASA/DoD Aerospace Knowledge Diffusion Research Project. Thomas E. Pinelli: Langley Research Center, Hampton, VA; Rebecca O. Barclay: Rensselaer Polytechnic Institute, Troy, NY; John M. Kennedy: Indiana University, Bloomington, IN

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Unclassified—Unlimited
Subject Category 82
Availability: NASA CASI (301) 621-0390

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
The U.S. government technical report is a primary means by which the results of federally funded research and development (R&D) are transferred to the U.S. aerospace industry. However, little is known about this information product in terms of its actual use, importance, and value in the transfer of federally funded R&D. To help establish a body of knowledge, the U.S. government technical report is being investigated as part of the *NASA/DoD Aerospace Knowledge Diffusion Research Project*. In this report, we summarize the literature on technical reports and provide a model that depicts the transfer of federally funded aerospace R&D via the U.S. government technical report. We present results from our investigation of aerospace knowledge diffusion vis-á-vis the U.S. government technical report, and present the results of research that investigated aerospace knowledge diffusion vis-á-vis the technical communications practices of U.S. aerospace engineers and scientists affiliated with, not necessarily belonging to, the Society of Manufacturing Engineers (SME).

14. SUBJECT TERMS
Knowledge diffusion; Aerospace engineers and scientists; Information use; and U.S. government technical reports

15. NUMBER OF PAGES
51

16. PRICE CODE
A04

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102